



Affordable Joining and Repair Technologies for Ceramics and Composites

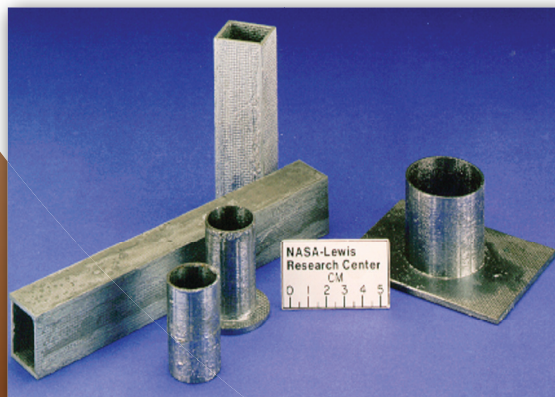
For low-cost manufacturing and repair of lightweight, high-temperature components

TECHNOLOGY OPPORTUNITY

Scientists at NASA's Glenn Research Center, in collaboration with the Ohio Aerospace Institute, have developed innovative processes, which help prolong component life, reduce replacement costs, and enable wider use of ceramics and composites. These technologies also improve the structural, thermal, and mechanical properties and performance of ceramics and ceramic matrix composites (CMCs). Ceramic joining technologies (LEW-16405-1, LEW-16661-1, and LEW-17009-1) enable low-cost manufacturing of ceramic components into large, robust, and three-dimensional shapes, including curved surfaces and internal cavities. Robust composite repair technologies (LEW-18390-1) refurbish and restore worn or damaged CMC components to prolong component life and reduce replacement costs. These award-winning technologies offer significant benefits for numerous systems (e.g., thermoelectric, batteries, supercapacitors, etc.) by providing lightweight components, longer component life, and lower costs for parts, operation, and maintenance.

BENEFITS

- **Enables greater use of ceramics and CMCs:** Enables the fabrication and application of ceramic and CMC components
- **Advantages over metals:** Components are lighter weight and insulative, with higher temperature capability and greater resistance to corrosion, wear, and thermal shock
- **Enables complex shapes:** Allows for large three-dimensional shapes to be fabricated, including curved surfaces and internal cavities
- **Robust:** Maintains good joint strength and integrity up to 1400 °C and higher
- **Increases component life:** Restores CMC durability and restores resistance to heat, corrosion, and wear
- **Reduces replacement costs:** Restores worn or damaged components
- **Low-cost manufacturing:** Integrates easily into various manufacturing processes; joint properties can be tailored



Ceramic composite joining.

APPLICATIONS

- Piston heads and rings; seals and cam rollers
- Cylinder sleeves
- Oxygen sensors
- Components for braking systems
- Engine valves for race cars
- Turbocharger rotors
- Gas turbine components for energy systems
- Heat exchangers and recuperators and radiant heater tubes
- Components for electronic industries and solar power systems

HOW IT WORKS

Robust joining and repair processes allow for low-cost manufacturing, longer component lives, and wider utilization of ceramics and CMCs. In ceramic joining, advanced silicon-carbide-based ceramic materials are bonded to one another to build up complex-shaped ceramic components. Typically, ceramic and CMC parts are limited to simple two-dimensional shapes due to processing limitations from methods using sintering, hot pressing, chemical vapor deposition, and fiber pre-forming. Ceramic joining allows for large three-dimensional shapes to be fabricated that may include curved surfaces or internal cavities. In composite repair, the worn or damaged CMC is refurbished to restore material properties, prolong durability, and reduce replacement costs. NASA's joining and repair technologies have received a NorTech Innovation Award and two R&D 100 awards.



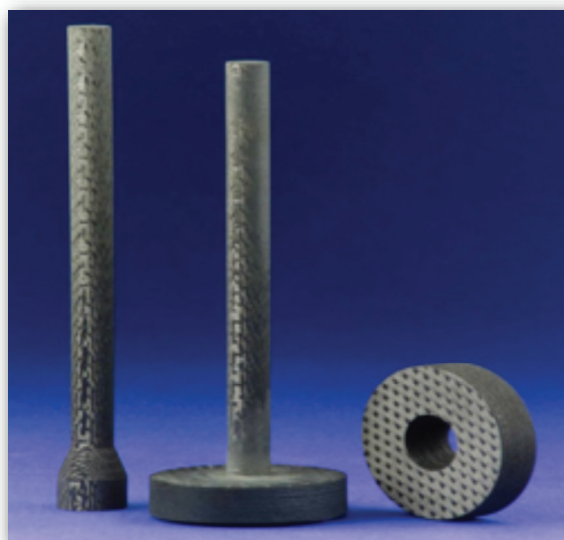
Testing of repaired specimens.



Flexible repair patches and high-temperature gaskets.

WHY IT IS BETTER

Ceramic components offer several benefits, including lighter weight, higher temperature capability, better thermal insulation for lower heat losses, and increased durability through improved resistance to heat, corrosion, and wear. Such benefits translate to lower costs for parts, operation, and maintenance. As an example of benefits, CMC brake rotors have been developed that reduce vehicle weight by 10 lb, last the life of the vehicle, and triple brake pad life. The use of ceramic joining to fabricate the brake system and composite repair to refurbish the pads can lead to reduced fabrication costs and increased part life. Similarly, CMC clutches have been developed that offer an 8 lb weight reduction, smaller size, improved wear, and high-temperature resistance.



Light-weight carbon-carbon composite valves for race car engines.

LICENSING AND PARTNERING OPPORTUNITIES

Glenn's Office of Technology Partnerships and Planning seeks to transfer technology to and from NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Ceramic and Composite Joining and Repair suite of technologies (LEW-16405-1, LEW-16661-1, LEW-17009-1, and LEW-18390-1) and/or partnering with NASA Glenn in this area.

FOR MORE INFORMATION

For more information about this and other technology licensing opportunities, please contact

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